STATE OF VERMONT
PUBLIC SERVICE BOARD

Investigation into the potential establishment of standards related to sound levels from the operation of generation, transmission and distribution equipment by entities subject to Public Service Board jurisdiction	)))))	Docket No. 8167

GREEN MOUNTAIN POWER'S RESPONSE TO PROCEDURAL ORDER RE: NEXT STEPS

By this filing, Green Mountain Power Corporation ("GMP") responds to the Public Service Board's ("Board") September 3, 2014 Order seeking written submissions on five questions. Each question, along with GMP's response to same, is set forth below.

I. BEST PRACTICES FROM OTHER JURISDICTIONS RELATED TO THE REGULATION OF SOUND FROM ENERGY FACILITIES.

Sound Level – Relative vs Absolute

Sound levels standards can be:

- Relative – an amount above a background sound level
- Absolute – a fixed value not to be exceeded
- Hybrid – a combination of the above.

Relative Standards and Hybrid Standards

Purely relative standards are not recommended for energy project noise.[1]

[1] Relative standards tend to be used in highly industrialized and dense urban areas. The existing conditions are such that the existing sound levels are at or approaching levels that are considered to cause activity interference. Relative standards are also the most difficult standard to enforce as shifting background levels and other contribution are always confounding variables.

- Background levels are low in much of Vermont. This can lead to a very low standard, well below what most people would find objectionable and well below levels that have been shown to cause activity interference, such as sleep disturbance.
- Places with higher background sound levels would thus be more suitable for development, but those tend to be where more people are located. Thus, it increases human exposure to noise.
- If the background level is based on varying actual levels during operation (rather than a fixed level based on preconstruction analysis), compliance is very challenging, due to impacts on background sounds due to variations in, among other things, wind speeds, weather, and (over time) vegetation and structures.

Ohio precedents for wind projects have a relative standard – 5 to 6 dBA above the long-term nighttime and daytime Leq. The standard, however, avoids the challenges associated with varying actual ambient sound levels, because it is fixed to one value over the entire project area based on the average of all preconstruction sound monitoring results. The preconstruction monitoring usually lasts two weeks. In this way, the standard does not change over time or place.

Many other jurisdictions also are based on fixedambient levels or regulatory floors, but the level is set based on factors other than preconstruction monitoring, such as a floor on the ambient sound level. Thisnot onlyavoids the complications of assessing the inherent variability in actual ambient sound levels, it also recognizes that a relatively significant increase over ambient sound levels may have a de minimis impact if the ambient sound level is sufficiently low.The province of Ontario, Canada, Alberta, Canada, the State of Oregon, the Netherlands, Denmark, New Zealand, and Germany are some of the jurisdictions that have established regulatory approaches for wind energy facilities whose sound limits do not require the existing levels to be measured.[2]Non-ambient based limits provide certainty for both

[2] Note that Oregon and New Zealand would allow measurements to support permitting higher sound levels in a project area should a developer choose not to accept the de minimis level. It is important to note that the

the developer and the community in that they provide a standardized approach that is not subject to temporal or spatial variation nor the adequacy of the pre-project monitoring analysis.

Limits must also consider how unusual, infrequent or upset events are to be considered. In the northern climates, icing of a turbine blade can yield a sound level that exceeds the normal operating or specified level. Such excursions may be allowed or require prescriptive action or management to minimize the exceedances.

If a relative noise standard were adopted by a jurisdiction, which we do not recommend, best practices should provide for a standardthat is based on an amount above a long-term Leq,and the standard is fixed and established for the lifetime of the project at all locations around the project. In addition, it should include the provisions of the Alberta, Oregon, and New Zealand approaches to establish a floor on the ambient sound level. That is the standard that would be the greater of a fixed value, such as 40 dBA (Alberta) and the value determined relative to background.

Relative sound levels do have a place in analyzing the impact of a project. For example, the California Environmental Quality Act ("CEQA") requires evaluation of both absolute and relative impacts:

> 1. Exposure of persons to, or generation of, noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;
>
> 2. Exposure of persons to, or generation of, excessive ground borne vibration or ground borne noise levels;

---

measurement approaches in Oregon and New Zealand do not rely on the Leq level, but statistical metrics such as the L_{50} (Oregon) or L_{90} (New Zealand). New Zealand standards (NZS 6808:2010 Acoustics – Wind Farm Noise) notes that:

> "It is not appropriate to measure wind farm sound using the L_{eq} because in a windy environment it is not possible to exclude the energy of higher wind speeds at the microphone contaminating measurements, especially when measuring relatively low level wind farm sounds….The L_{90} sound level is that level equaled or exceeded for 90% of the time interval. It approximates the mean minimum sound level and is unaffected by higher sound levels of short-term influence cause by the energy in wind gusts which would, for example, determine the L_{eq} level and not represent the sound level due to the wind farm operation alone."

> 3. Substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project; or
>
> 4. Substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.[3]

When this analysisidentifies the potential for a significant adverse impact, then feasible mitigation is considered to reduce or eliminate the impact. Mitigation can take many forms including source controls (lower noise equipment, equipment enclosures), path controls (barriers at either the source or the receptor) and/or mitigation at the receptor (acoustical retrofit of windows).

Absolute Standards

Absolute standards are the most common way of controlling noise from energy facilities. For example, Maine's wind energy and general noise standard are fixed values. Vermont and New Hampshire precedents for wind projects tend to have fixed standards based on a one-hour Leq. Connecticut has a fixed statewide standard. Illinois has a fixed standard based on the octave band frequency of the sound.

The Maine standard for wind turbine sound is 42 dBA, measured as the arithmetic average of 12 consecutive 10-minute Leqs meeting certain worst-case meteorological conditions. This standard is applied during the nighttime at "protected areas," which is defined as 500 feet from any residence or the property line, whichever is closer. The daytime limit is 55 dBA. Outside of protected areas, the standard is 75 dBA.

For other projects, including other energy projects, the Maine residential standard depends on the background sound level in the area. If the area has a background sound level below 45 dBA/35 dBA daytime/nighttime, respectively, the standard is 55 dBA daytime/45 dBA nighttime, measured as a one-hour Leq. If the background sound level is above these quiet area levels, then the standard is 50 dBA

[3] Section XII of Appendix G of CEQA's guidelines (California Code of Regulations, Title 14, Appendix G).

daytime and 50 dBA nighttime. The exception is when the background levels are more than 5 dB higher than these latter levels, in which case, the standard is 5 dB below the background level.

The advantage of Maine's approach is that it establishes separate fixed limits for areas with both higher and lower background sound levels, without it being strictly relative to background.

The World Health Organization ("WHO") Guidelines for Community Noiserecommends a 16-hour Leq of 50 dBA to prevent moderate daytime annoyance and an 8-hour Leq of 45 dBA (exterior to bedroom window) to prevent sleep disturbance. The more recent WHO Nighttime Noise Guidelines for Europe introduces an annual average nighttime guideline of 40 dBA to project against adverse sleep impacts.

Low Frequency Sound

Low frequency sound can become a problem with certain types of energy projects at high enough sound levels. A fixed A-weighted decibel standard may not capture problems with low frequency sound that can be annoying.

Illinois's approach is to set a standard based on octave band sound levels. For the low-frequency range, their standard for energy facility impacts to residential areas is 72 dBZ at 31.5 Hz and 71 dBZ at 63 Hz.

ANSI S12.2-2008, "Criteria for Evaluating Room Noise" sets limits for low frequency sound and infrasound which may be inaudible, but can create acoustically induced vibrations and rattles. The standard is shown below:

Table 6 — Measured sound pressure levels for perceptible vibration and rattles in lightweight wall and ceiling structures

Octave-band center frequency (Hz) (band number)	16 (12)	31.5 (15)	63 (18)
Clearly perceptible vibration and rattles likely	75	75	80
Moderately perceptible vibration and rattle likely	65	65	70
NOTE Values are sound pressure levels in decibels 20 μPa. (See [12].)			

They are interior limits. If these values are used for exterior limits, then some adjustment should be made for the attenuation of sound from outdoors to indoors.

<u>Tonality</u>

Tonal sounds can be more annoying than broadband sound. For wind turbine projects, many Boarddecisionshave disallowed any tonal sound. Most jurisdictions allow for tonal sound, but apply a penalty if tonal sound is detected. A good example is Maine. For wind turbine projects, tonal sound is tested by comparing the 1/3 octave bands from any 10-minute Leq to the criteria that is the same as ANSI S12.9 Part 4 Annex C. A 5 dB penalty is added to that 10-minute period if it is tonal. For other projects, including energy projects, the tone must be audible, and the 5 dB penalty is added to only the periods that are tonal during the hour.

ANSI S12.9 Part 4 also uses a 5 dB penalty for tonal sound, although it applies it to a long-term Ldn rather than an hourly Leq.

<u>*Variances and Exceptions*</u>

Many jurisdictions allow for developers to make agreements with landowners such that they are not subject to applicable sound standards. For example, landowner agreementsare common in such areas as Michigan, Ohio, Illinois, and Maine.

Maine also allows for a variance from sound level limits if "a development is deemed necessary in the interest of national defense or public safety and the applicant has shown that the sound level limits cannot practicably be met without unduly limiting the development's intended function, and [] a finding is made by the Department that the proposed development will not have an unreasonable impact on projected locations…"

Exceptions in many noise standards are also granted for such things as emergency sirens and routine lawn maintenance, and unamplified voices.

Construction Noise

In California, noise due to construction activities is usually considered to be less than significant in terms of CEQA compliance if:

• The construction activity is temporary; and

• The use of heavy equipment and noisyactivities is limited to daytime hours.

Construction noise estimates and comparisons do not use the L_{90} metric, but rather rely on the energy average Leq.

Maine's daytime construction noise standard for all projects other than wind energy is as follows

Duration of Activity	**Hourly Sound Level Limit**
12 hours	87 dBA
8 hours	90 dBA
6 hours	92 dBA
4 hours	95 dBA
3 hours	97 dBA
2 hours	100 dBA
1 hour or less	105 dBA

Nighttime construction is only allowed with prior approval and must meet the standard sound level limits of 55 dBA and not to exceed 90 days.

II. PROJECT PLANNING AND PRE-APPLICATION CONSULTATION.

Best practices include:

- Consideration and development of energy overlay zones – identifying areas where energy development is encouraged. Conversely, exclusion or restricted zones where it is to be discouraged.
- Community meetings/stake holder outreach.
- Ensuring a fair and open process and one where communities that host projects benefit from them is likely to facilitate greater community acceptance.

Several studies support the general conclusion that concerns about fairness and equity influence attitudes.[4]These issues have been identified in the peer-reviewed literature as one factor influencing the potential for noise annoyance from various sources of noise. Maris et. al. evaluated the influence of procedural fairness on sound management of aircraft exposure and found that procedural fairness was an effective non-acoustical method to reduce annoyance.[5] A sociological evaluation of rural wind farm development in Australia also found that community responses to wind facilities vary for a variety of non-acoustical reasons such as political objections to renewable energy or environmental policies or general anti-development stances.[6]

III. BEST PRACTICES FOR PRE-CONSTRUCTION SOUND MODELING.

For conventional power plants, there are a number of modeling techniques that have been successfully used. Modeling of conventional power facilities should identify the sound power level of major components and the source of that data. Modeling should be conducted on an octave band basis and attenuation related to ground and topography be assessed. Mitigation measures incorporated into the

[4] Chief Medical Officer of Ontario, *The Potential Health Impact of Wind Turbines*¸May, 2010.

[5] Maris, E. et al, "Evaluating noise in social context: The effect of procedural unfairness on noise annoyance judgments", J. Acoustical Society of America, December 2007; *See also* Maris, E. et al, "Noise within the social context: Annoyance reduction through fair procedures." J. Acoustical Society of America, April 2007.

[6] Hall, N., Ashworth, P., Shaw, H. "Exploring community acceptance of rural wind farms in Australia: a snapshot", CSIRO Science into Society Group. January 2012

facility should be identified and potential contingency measures considered. The purpose of the modeling should be to identify if it is reasonable to expect the facility can comply with the applicable limit. Often there is an EPC or engineering contractor who is responsible for construction and performance of the facility and their responsibility includes ensuring the emissions criteria (air, water as well as noise) are complied with and substantial penalties if they are not. During the permitting phase of the project, detailed engineering has not been completed and specifications for noise control measures are often preliminary or conceptual. It is beneficial if the regulatory process establishes the limits, but the engineering team is able to maintain flexibility determining the detailed measures needed to achieve the limits. That is, permits should avoid specifying specific attenuation requirements for various components and allow the engineering design team to use all the tools available to them as the design progress to achieve the performance-based limit.

For wind energy facilities, it is recommended that modeling methods be specifiedin detail to ensure results are standardized and comparable. Members of the United Kingdom Institute of Acoustics, a professional society of noise control professionals in the United Kingdom ("UK"), recommended adoption of a G = 0.5 ground factor coupled with source sound power data includes a warranty margin or the test data uncertainty or, alternatively, source sound power data based on the reported test levels coupled with the use of a G = 0.0 ground factor.Other methods can be used for certain terrain types. These methods are similar to those identified byboth Ontario, Canada as well as the National Association of Regulatory Utility Commissioners.They are also similar to approaches taken in Vermont.

IV. BEST PRACTICES FOR POST-CONSTRUCTION SOUND MONITORING.

For conventional generation there are well-established methods to document operational sound levels. The primary difference between conventional generation and wind energy is that variations in ambient sound and project sound are more closely correlated for wind projects, since project output increases as wind speed (and therefore sound) increases. When the permit limit is close to existing levels, the California Energy Commission allows measurements to be conducted closer to the facility (i.e., 400 ft.) where the facility noise is dominant and for the A-weighted facility level to be extrapolated (modeled) at the point of compliance.

Measurements of wind energy facilities may be complicated by the sound of the wind induced noise over the microphone or vegetative rustling. Several jurisdictions (i.e., The Netherlands and Denmark) have avoided this complication by measuring close to the turbine (per IEC 61400-11) where the signal to noise ratio is high to verify the turbine sound power level is not exceeding the specified or modeled level. However, this is rarely practical for wind projects set on ridgetops, as the minimum downwind measurement distance can often be off the edge of the ridge and monitoring closer to the project means greater distance from the protected areas (such as existing residences).

When noise measurements at compliance points are required, the following outlines evolving best practices:

1. The noise limits apply to turbine noise only as the project does not have control over other sources of noise (including ambient).

2. If in response to a complaint, it is desirable to monitoring under meteorological/operating conditions corresponding to the complaint. Normally downwind conditions represent the worst case (highest) sound level. Downwind is generally defined as +/- 45 degrees. As the noise from the closest turbines will generally dominate the measurements, downwind conditions should typically be evaluated from these turbines.

3. Sound level equipment should be time synchronized with the turbine SCADA system and any meteorological monitoring equipment.

4. Measurement locations should be agreed upon by the lead agency. Locations should be selected to minimize the influence of non-project noise sources.

5. Measurements shall be carried out for a two-week period or longer if necessary to capture the relevant conditions.

6. Measurement intervals would generally be 10 minutes, consistent with typical turbine and meteorological data collection efforts.

7. Data must then be processed to focus on time periods when the facility was operating under the relevant conditions and non-project sources were minimal. This will generally be during the

nighttime hours. Detailed analytical guidance should be developed that is consistent with the permit limit.

8. Measurement equipment should be Type 1, precision, field calibrated before and after the measurement and traceably calibrated within the past 2 years. Microphone should be outfitted with oversize windshields or secondary windshields to limit the influence of wind induced noise. Microphone height wind speed and rain data should also be collected at the sound measurement location.

V. EFFECTIVE MODELS FOR COMPLAINT RESOLUTION.

Both the California Energy Commission and the Alberta Utilities Commission provide forms to document and investigate complaints.

The regulators in the Netherlands noted that it is not possible to satisfy 100% of the people 100% of the time, rather the goal was to limit the number of potentially highly annoyed individuals from wind energy facilities to be consistent with other sources of noise.